the years 1858 and 1878, and thirty quarto volumes containing the measures of many of them. The *Annals of the New York Academy of Sciences*, vol. vi., June 1891, contains a catalogue of these negatives. There are 139 negatives of the sun taken between 1860 and 1874, each of which has the time of exposure marked upon it. Several negatives were taken of the eclipses of 1860, 1865, and 1869. The solar spectrum is the subject of 160 negatives and 14 positives. The list of lunar negatives numbers 408, 40 of which are covered for protection. Mars was photographed in 1877, and the transit of Mercury in the following year. It is hoped soon to issue reductions of the measures of the numerous negatives of stars and clusters.

THE INSTITUTION OF MECHANICAL ENGINEERS.

A GENERAL meeting of the Institution of Mechanical Engineers was held on Wednesday and Thursday evenings of last week, the 28th and 29th ultimo. The meeting took place at the Institution of Civil Engineers, Great George Street, the theatre having been lent by the Council of the latter Society for the purpose. The President, Mr. Joseph Tomlinson, occupied the chair, and there were two papers on the agenda. The first of these, taken at the Wednesday's sitting, was "On some Details in the Construction of Modern Lancashire Boilers," by Mr. Samuel Boswell, of Manchester. The evening of Thursday was occupied with the reading of "The Report to the Alloys Research Committee," made by Prof. W. C. Roberts-Austen, C.B., F.R.S.

The first paper does not call for much attention at our hands. It dealt exclusively with boiler-making practice, and can hardly be of much interest outside the boiler-shop and draughting office. Within these limits the paper is one of great value, and therefore will occupy a most fitting place in the Proceedings of the Institution. The contribution of Prof. Roberts-Austen was of a very different description; and although it may not appeal so directly to the majority of mechanical engineers, it can hardly fail to improve the practice of engine construction, and advance the science of the production of mechanical energy many steps nearer that ideal of efficiency which is the goal all good engineers should keep in view. We have on previous occasions dwelt upon the excellent work done by the various Research Committees appointed by the Council of this Institution, and we can think of no better way in which the surplus funds of the Institution could be spent. Of all these Research Committees, it may be said that that appointed to consider the question of alloys is the most comprehensive and important, for we appear to be fast coming to a period when engines will consist almost wholly of two alloys—namely, brass and steel. Cast-iron will naturally continue to be used for massive parts where comparatively great weight is of small importance, but wrought-iron is every day giving place to steel, and steel castings have already almost entirely superseded those of iron in positions where it is desirable to combine lightness and strength.

Prof. Roberts-Austen's report is a long document occupying twenty-four pages of the Proceedings, and illustrated by several diagrams. We shall therefore, with the space at our command, be able to do little more than give an outline of its scope, or at any rate we can do no more than dwell on a few of the more salient features. In dealing with the question of iron and its alloys, the author assumed the reader to have an acquaintance with the work of the talented French physicist Osmond, of whom, as is well known, Roberts-Austen is a great admirer. Osmond holds that the results of his experiments show that there are two distinct varieties of pure iron—namely, the α or soft form, and the β or hard form. M. Osmond, it will be remembered, set forth his views in a paper read at the meeting of the Iron and Steel Institute, held in 1890.[1] Mr. Roberts-Austen had previously commenced an investigation upon the application of the "periodic law" of Newlands and Mendeleeff to the mechanical properties of metals, and the Research Committee requested him to carry his work in this direction still further. This law, as originally expressed, states that "the properties of the elements are a periodic function of their atomic weights." It has been shown that the effect of impurities added to gold is nearly proportional to their atomic volume, the larger the volume of the atom the greater being its effect.[2] It became interesting to determine, therefore, whether this holds good for other metals. Osmond had determined that the action of impurities on iron does appear to be in accordance with the periodic law; and he had arranged the elements in the following order in accordance with their atomic volumes, found by dividing their atomic weight by their specific gravity:—

I.		II.	
Carbon	3·6	Chromium	7·7
Boron	4·1	Tungsten	9·6
Nickel	6·7	Silicon	11·2
Manganese	6·9	Arsenic	13·2
Copper	7·1	Phosphorus	13·5
		Sulphur	13·7

Osmond pointed out that the elements in column I., whose atomic volumes are smaller than that of iron (7·2), delay during cooling, *cæteris paribus*, the change of hard iron into soft iron, as well as that of "hardening carbon" into "carbide carbon." For these two reasons they tend to increase, with equal rates of cooling, the proportion of hard iron that is present in the cooled iron or steel, and consequently the hardness of the metal. The elements in column II. tend to raise, or maintain at its normal position during cooling, the temperature at which the change of hard to soft iron takes place. Further, they render the inverse change during heating more or less incomplete, and usually hasten the change of dissolved or hardening carbon to carbide carbon. Thus they maintain iron in the soft state at high temperatures, and must therefore have the same effect in the cooled metal. In this way they would act on iron as annealing does, rendering it soft and malleable, did not their individual properties, or those of their compounds, mask this natural consequence of their presence. The essential part played by foreign elements alloyed with iron is therefore either to hasten or to delay the passage of iron during cooling to an allotropic state; and to render the change more or less incomplete in one direction or the other, according to whether the atomic volume of the added impurity is greater or less than that of iron. In other words, foreign elements of low atomic volume tend to make iron itself assume or retain the particular molecular form which possesses the lowest atomic volume; whilst elements with large atomic volume produce a reverse effect. The report goes on to point out that the effect of impurities on iron is far more complicated than in the case of gold; the latter being probably more simple in its molecular structure. Also if iron, by itself, can exist in two widely different states, the mechanical properties will be affected by the proportion of each. Lead also, which was one of the metals the Committee selected for investigation, probably exists in more than one modification. The author had made many experiments on the mechanical properties of lead as affected by a small quantity of impurity, but had not brought the results to any concordant or definite conclusion, and the inquiry was laid aside for a time. The fundamental necessity in carrying out the work of the Committee was a trustworthy pyrometer which would measure higher temperatures, and fortunately an instrument which appears to fulfil these conditions is now to be procured. This, we need hardly say, is the Le Chatelier pyrometer. This instrument consists of a thermo-couple of platinum and platinum-rhodium wire, the record being obtained by the measurement of the electric current produced. An autographic record is obtained by means of a spot of light thrown from a mirror attached to the galvanometer which measures the current. This spot of light is thrown on to a sensitized plate (Eastman's film) which is caused to travel by suitable means so as to give the time factor. The amplitude of the deflection naturally gives the temperature of the substance which is supplying the heat to the thermo-couple The calibration has been carefully effected by observations at known temperatures; and the instrument has been tested by observations in connection with the liquation of silver-copper alloys, about which a good deal is known.

The report next proceeds to deal with the effect of small quantities of impurity on the freezing point of gold—a metal which offers special advantages for investigations of this nature, as it may be prepared in a very high degree of purity, and is not liable to contamination by oxidation. Moreover, much is already known of its mechanical and thermal properties as influenced by small quantities of impurity. The effects of certain alloys upon gold are given in the report, and are well worth study on the part of those inquirers who wish to prepare them-

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[1] See also *Comptes rendus*, vol. cx., 1890, p. 346.

[2] Philosophical Transactions of the Royal Society, vol. clxxix., 1888, p. 339.

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selves for a better understanding of the alloys of metals which come within the scope of every-day experience.

From the engineer's point of view, as the report states, the most interesting information which the pyrometer has yet afforded is connected with the measurement of the internal stresses in iron and steel. The molecular change which takes place in steel must be of vital importance when the metal is subjected at high temperature to mechanical operations such as rolling or forging. "Do the molecular changes in the iron take place at one moment throughout the mass of metal? that is, is the rate of cooling approximate throughout the mass, or does the external portion of the ingot cool so much more rapidly than the centre as to allow the molecular changes in the iron, and the relation between the carbon and the iron, to become completed near the surface long before they take place in the interior of the mass?" The pyrometer used allows some insight to be gained into this hitherto unassailable problem. A small ingot of mild steel had two holes drilled into it, one near the circumference, and the other at the centre. The ingot was heated, and a thermo-junction was inserted in each hole. In this way curves of temperature were obtained simultaneously. With the mild steel the evidence as to molecular change was but slight. Another ingot of steel, containing 0·799 per cent. of carbon, 0·084 per cent. of silicon, and 0·412 per cent. of manganese, was tried in the same way. The initial temperature at the centre was 1160° C. The curve showed the molecular change at 880° C., and the carbon change at 696° C. At the circumference the carbon change took place no less than four minutes earlier than at the centre, and at the lower temperature of 665° C. This is a most important point, as the rate of cooling, as Osmond has pointed out, has a measurable effect upon the temperatures at which molecular change occurs. The great internal strain which must be set up is evident when it is borne in mind that the carbon change is accompanied by a considerable alteration of volume. It is pointed out in the report that "there can be but little question that such experiments well deserve careful attention, and, in the hands of competent observers, should be fruitful of results."

On the conclusion of the reading of the paper, the President called for a discussion, when Dr. Anderson was the first to rise. He spoke in terms of warm praise as to the value of the work done by Prof. Roberts-Austen. As an instance, he mentioned that the method described in the report, by which the temperatures of an ingot could be obtained simultaneously at the centre and the circumference, would be of the greatest use in dealing with the large pieces of steel used for gun-hoops; and he expected great help from this in the work at the Royal Arsenal.

Mr. R. Hadfield, of Sheffield, followed. He gave a summary of the effect of the most prominent alloys of iron. This table will form a useful appendix to the report when published in the Transactions of the Institution.

Prof. Howe, of Boston, gave an instance in which the Le Chatelier pyrometer had been turned to good practical account. This was in the Rodman system of gun-casting. In that process it was most desirable to know the varying temperatures of different parts of the cast, but naturally this had been hitherto impossible. By inserting a thermo-couple in the mould it was possible to get this information at all times. He thought the Le Chatelier pyrometer the greatest boon that metallurgists had received for very many years.

The next speaker was Prof. Arnold, of Sheffield, who made a certainly vigorous speech. We think, however, that he was rather carried away by his enthusiasm. To say that the work done by the author of the report was "not worth a rush," is rather straining the prerogative of rhetoric; and we failed to see, when Prof. Arnold descended to facts, that he justified the florid language of his exordium. Prof. Roberts-Austen, in his reply, gave an example of forbearance and good temper which it would be well if men of science could often follow. It was satisfactory to notice that the feeling of the meeting was by no means in accordance with Prof. Arnold.

Mr. Stromeyer added to the work done a useful table in which were collated the opinions of various authorities on the effect of alloys upon iron. The table was not read, but will be published in the Proceedings. Such work as this is very acceptable. It involves a great deal of labour and brings but small return in the way of praise and glory, which of course are two things to which a true follower of science is profoundly indifferent.

Mr. Stead, of Middlesborough, protested against Prof. Arnold's remarks, and spoke of the value of the author's work. The testimony of Mr. Stead is valuable, as he combines the position of a practical investigator, working for commercial ends, and a man of science.

The meeting broke up after passing the usual votes of thanks.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Junior Scientific Club held their first meeting this term in the Physiological Laboratory at the Museum, under the presidency of Mr. R. S. Gunther, of Magdalen.

Mr. W. Pullinger, of Balliol, read a paper on volatile platinum compounds, and exhibited prepared specimens.

Mr. A. F. S. Kent, of Magdalen, indicated improvements in the manipulation of photo-micrography whereby the effect of tremors was excluded, and passed through the lantern some very excellent slides which he had taken from negatives obtained by his new method.

Mr. G. E. C. Pritchard, of Hertford, exhibited specimens of Bacteria, and described the method whereby they had been obtained and prepared for microscopic exhibition.

Dr. Collier read a paper of a very interesting character on the physiology of muscular exercise with special reference to training, in the course of which he traversed some statements recently made by Sir Morell Mackenzie, to the effect that fatigue was due to the cessation of blood flowing to the muscles. Dr. Collier would rather attribute fatigue to the development of waste-products in the muscle, formed too rapidly for the blood to remove them, and quoted experiments carried out on frogs which seemed to support this view.

CAMBRIDGE.—The Agricultural Education Syndicate, in view of a grant of £400 a year from the Cambridgeshire County Council, recommend that a lecturer in agricultural science, who shall also be director of agricultural studies, should be appointed at a stipend of £500. They also propose that a second lecturer be appointed at a stipend of £300. These two lecturers would take between them the subjects of agricultural botany and agricultural chemistry.

The degree of M.A. *honoris causâ* has been conferred on the distinguished entomologist Mr. D. Sharp, F.R.S., Curator in Zoology at the University Museums.

Dr. Sir A. Geikie and Dr. T. G. Bonney have been appointed adjudicators of the Sedgwick Prize of 1895.

At St. John's College, on November 2, the following were elected to the vacant Fellowships: William McFadden Orr, B.A., Senior Wrangler, 1888; Edward Ernest Sikes, B.A., First Class (Division 1), Classical Tripos, 1889, Newton Student in Archæology; Percival Horton-Smith, B.A., First Class Natural Sciences Tripos, 1889-90 (distinguished in physiology), late Hutchinson Student in Physiology.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 26.—M. Duchartre in the chair.—On the theory of Hertz-oscillations, by M. H. Poincaré.—On a new mineral—boleite, by MM. Mallard and E. Cumenge. The new mineral occurs with copper in volcanic tuff and conglomerate found near Santa Rosalia, Lower California. It crystallizes in the cubic system, and its composition is represented by the expression $PbCl_2 + CuO.H_2O + \frac{1}{3}AgCl$. Its density is a little greater than that of calcite; cleavage easy parallel to the faces of cube, much less easy parallel to faces of octahedrons. Approximate index of refraction, 2·07.—Vasomotor action of bacteria, by M. Ch. Bouchard.—Contribution to the botanical history of the truffle (fourth note): *Kama* of Bagdad (*Terfezia Hafizi* and *Terfezia metaxasi*) and of Smyrna (*Terfezia Leonis*), by M. Ad. Chatin.—On a storm observed at the Canary Islands. This is an extract from a memoir by M. de la Monneraye.—On the original causes of cyclones, and on their precursory signs: extract from a memoir by M. Le Goarant de Tromelin.—On the theory of the voltaic pile, by M. P. Duhem.—Experimental researches on a category of capillary phenomena, with an application to the analysis of alcoholic liquids and others, by M. Emile Gossart.—On bromo-

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